Remarks

Claims 1-16 are pending in the present application. The indication that claims 2, 5, 6, 9, 11, 12 and 16 are directed towards allowable subject matter is greatly appreciated.

Claims 1, 3, 4, 7, 8, 10 and 13-15 stand rejected under 35 U.S.C. § 103(b) as being unpatentable over Yamagata (US 6,822,447 B1) in view of Igeta et al. (US 6,045,262)

Claims 1-16 remain in the application unamended.

THE PRESENT APPLICATON

The present application relates to sensing the position of subject table or other movable subject support used in diagnostic imaging. Typically, such systems require a position, or motion, control system by which a subject is transported on a subject support into, and positioned within, the imaging volume. However, mechanical and control system errors tend to contribute to low levels of position accuracy and repeatability problems when producing images.

In light of this, an embodiment of the present invention includes a movable subject support 52 for moving a subject within the examination region. In one embodiment, the subject support is a wheeled table or other movable support that is adapted to mechanically dock with the magnetic resonance imaging apparatus. In another embodiment, the subject support is integrated with an MRI system and is movable therein. Regardless of the type of support, the subject support is movable for positioning the subject within the examination region.

The position of the support 52 is controlled by the position controller 60. In one embodiment, the position controller 60 includes a motor drive and linkage to the patient support which controls the position of the patient support as is known by one of ordinary skill in the art. Alternately, a drive pinion, pulley system, stepper motor, or the like controls the position of the table.

As described more fully in the application, the MRI apparatus also includes a position sensor, or encoder, 53 for directly detecting the position of the subject support with respect to a given reference frame. In one embodiment, the position sensor includes a graduated scale 54 disposed on the subject support and first (or coarse) and second (or fine) read heads 55, 56 disposed on the MRI housing 13 to make such direct measurement.

THE YAMAGATA REFERENCE

Yamagata, on the other hand, discloses a patient couch controller 16, under the control of the system controller 14, outputs movement information for the purpose of moving the tabletop 6 to the patient couch 2, this information indicating the amount of horizontal movement of the tabletop 6 and the amount of up and down movement of the tabletop 6.

The patient couch controller 16 outputs movement amount information to the patient couch 2 for the purpose of moving the patient couch 2 so that the center of the region of imaging (region of diagnosis or region of treatment) of the patient P is caused to coincide with the center of the static magnetic field and center of the gradient magnetic field. The patient couch 2, in response to the movement amount information from the patient couch controller 16, moves the tabletop 6 in the horizontal and vertical directions, using the horizontal movement mechanism and vertical movement mechanism.

For horizontal movement, Yamagata teaches that FIG. 4A and FIG. 4B show the horizontal movement mechanism of the patient couch that is provided in the MRI apparatus according to the first embodiment of the present invention. FIG. 4A provides a rear view of the horizontal movement screw box and the horizontal movement mechanism that is provided on the tabletop. FIG. 4B provides a side view of the horizontal movement screw box and the horizontal movement mechanism that is provided on the tabletop. The horizontal movement mechanism 24 is described below, with reference made to FIG. 4A and FIG. 4B.

Referring to FIG. 4A, on the rear side of the tabletop 6 are formed two rows of front-to-back movement screw grooves 25, on the left and right, for the purpose of moving the tabletop 6 forward and back, and left-to-right movement screw grooves 27, disposed between the two rows of front-to-back movement screw grooves 25, for the purpose of moving the tabletop 6 to the left and right.

Inside the horizontal movement screw box 2c are provided front-to-back movement screws 29, which is disposed so as to mesh with the front-to-back movement screw grooves 25, and a left-to-right movement screw 33, which is disposed so as to mesh with the left-to-right movement screw grooves 27. The front-to-back movement screw 29 and the left-to-right movement screw 33 are mounted to a shaft 31.

According to a horizontal movement mechanism configured as noted above, when movement amount information that indicates an amount of horizontal movement is sent from the patient couch controller 16, the screws 29 and 33 rotate in response to this amount of horizontal movement information sent from the patient couch controller 16. For this reason, the screw grooves 25 and 27 that mesh with the screws 29 and 33 move, thereby causing the tabletop 6 to move within the horizontal plan (front-to-back and left-to-right), in response to the amount of horizontal movement that was received.

For vertical movement Yamagata teaches, with respect to FIG. 5, the vertical movement mechanism that is provided in the MRI apparatus according to the first embodiment of the present invention. As shown in FIG. 5, a vertical movement mechanism 34, which causes the tabletop 6 to move up and down, is provided on the tabletop 6.

The vertical movement mechanism 34 is formed by a first holding section 35a, which is mounted to one end of a hydraulic cylinder 34a and which is provided in the patient couch base 2a, and a second holding section 35b, which is mounted to the other end of the hydraulic cylinder 34a and which is provided in the horizontal movement screw box 2c. The hydraulic cylinder 34a causes the horizontal movement screw box 2c to move up and down, with respect to the position of the patient couch base 2a, in response to hydraulic pressure.

According to a vertical movement mechanism 34 configured as noted above, when amount of movement information indicating the amount of vertical movement is sent from the patient couch controller 16, the hydraulic cylinder 34a, in response the amount of vertical movement information from the patient couch controller 16, uses hydraulic pressure to cause the horizontal movement screw box 2c to move up and down, via the second holding section 35, thereby enabling the up and down movement of the tabletop 6.

With respect to another embodiment, Yamagata teaches that when performing positioning of the region of diagnosis with the center O of the magnetic field (static magnetic field or gradient magnetic field) a manual or motorized mechanical means is used to automatically perform approximate positioning of the tabletop 6. For this reason, the MRI apparatus of the second embodiment has a system controller 14a, a T/R unit 15, a patient couch controller 16a, a magnetic gradient power supply 17, a position sensing unit 52, a 3-dimensional position sensor transmitter 53, and a 3-dimensional position sensor receiver 55. As shown in FIG. 13, the T/R coil 19 that is attached to the region of

diagnosis of the patient P has the 3-dimensional (or 2-dimensional) position sensor transmitter 53 mounted to it. A 3-dimensional position sensor receiver 55 is mounted, for example, at the center of the linking section 12 (position corresponding to directly above the magnetic field center O). The 3-dimensional position sensor receiver 55 receives position information that is sent from the 3-dimensional position sensor transmitter 53. The position sensing unit 52 accepts the position information of the 3-dimensional position sensor transmitter 53 that was received at the 3-dimensional position sensor receiver 55, and sends this information to the system controller 14a. The system controller 14a sends the position information of the 3-dimensional position sensor transmitter to the patient couch controller 16a. The patient couch controller 16a calculates the difference (distance) components between the position information of the 3-dimensional position sensor transmitter 53 that was sent from the system controller 14a and the position information of the center O of the static magnetic field and gradient magnetic field, and controls the patient couch 2 so as to move the tabletop 6 by the amounts indicated by these difference components. See, Yamagata, column 8, line 40 – column 9, line 7.

THE IGETA REFERENCE

The relevant portion of Igeta et al which has been cited by the Office Action states that that in the light of the state of the art described above, it is an object of the present invention to provide a control apparatus for controlling a table of a medical diagnosis system, which apparatus includes a positioning servo-control system for controlling the table so as to maintain it at a predetermined desired position and a force control system for moving the table in accordance with a position change quantity corresponding to a manipulating force applied by an operator, wherein the positioning servo-control system and the force control system can be changed over in response to manipulating operation of the operator.

Another object of the present invention is to provide a control method for controlling the movement of a table in a medical diagnosis system. See Igeta et al. column 2, lines 13-27.

COMBINATION OF REFERENCES

The Office Action clearly admits that Yamagata does not teach or suggest a position controller for directly measuring the position of the subject support. To support its rejection of the claims at issue, the Office Action points to Igeta et al. and states that Igeta et al. teaches a position controller for directly measuring the position of the subject support. In combining the references, the Office Action states that it would have been obvious to one of ordinary skill in the art at the time the invention was made to adapt teaching of Igeta et al. with the teaching of Yamagata to improve controlling of the subject motion.

THE CLAIMS DISTINGUISH OVER THE PRIOR ART OF RECORD

Claim 1 is directed to An MRI apparatus comprising a main magnet for generating a main magnetic field in an examination region; a plurality of gradient magnets for generating magnetic field gradients in the main magnetic field; a radio frequency coil for transmitting radio frequency signals into the examination region and exciting magnetic resonance in a subject disposed therein; a radio frequency coil for receiving the magnetic resonance signals from the subject; a subject support for supporting the subject; a position controller for controlling the position of the subject support within the examination region; and a position sensor for directly measuring the position of the subject support.

Applicants respectfully submit that the Office Action has not established a prima facie case of obviousness.

First the Office Action has not established that the combination of references teach or suggest all of the elements of claim 1. The Office Action readily admits that Yamagata does not include the necessary claim elements of claim 1. While relying on the Igeta et al. reference to overcome Yamagata's shortcomings, the Office Action broadly states that it teaches a controller for directly measuring the position of the subject support. However, as noted above, Igeta et al. teaches controlling the table so as to maintain it at a predetermined desired position and a force control system for moving the table in accordance with a position change quantity corresponding to a manipulating force applied by an operator, wherein the positioning servo-control system and the force control system can be changed over in response to manipulating operation of the operator. Applicants respectfully submit that the Office Action has failed to identify any teaching in Igeta et al. which teaches a

position controller for controlling the position of the subject support within the examination region; and a position sensor for directly measuring the position of the subject support.

Second, assuming arguendo that the references did teach all of the elements of claim 1, the Office Action has not established any suggestion or motivation to combine the references. More specifically, the Office Action broadly states that combining the references would improve controlling of the subject motion. To that end, the Office Action provides no support for how or why the control would be improved.

In light of the foregoing, Applicants respectfully request reconsideration and withdrawal of the rejection of claim 1.

Claims 3 and 4 ultimately depend from claim 1. For at least the reasons set forth above in connection with the patentability of claim 1, Applicants respectfully request reconsideration and withdrawal of the rejection of claims 3 and 4.

Claim 7 is directed to an MRI apparatus comprising: main field means for generating a main magnetic field in an examination region; gradient means for generating magnetic field gradients in the main magnetic field; radio frequency transmit means for transmitting radio frequency signals into the examination region and exciting magnetic resonance in a subject disposed therein; radio frequency receive means for receiving magnetic resonance signals from the subject; subject support means for supporting the subject; position control means for controlling the position of the subject support within the examination region; and position sensing means for directly measuring the position of the subject support.

The reasons stated above in connection with the patentability of claim 1 can be applied *mutatis mutandis* to claim 7. Accordingly, Applicants respectfully request reconsideration and withdrawal of the rejection of claim 7.

Claims 8 and 10 ultimately depend from claim 7. For at least the reasons set forth above in connection with the patentability of claim 7, Applicants respectfully request reconsideration and withdrawal of the rejection of claims 8 and 10.

Claim 13 is directed to an MRI method comprising the steps of: generating a main magnetic field in an examination region; generating magnetic field gradients in the main magnetic field; transmitting radio frequency signals into the examination region for exciting magnetic resonance in a subject disposed therein; receiving magnetic resonance

signals from the subject; controlling the position of a subject support within the examination region; and directly measuring the position of the subject support.

The reasons stated above in connection with the patentability of claim 1 can be applied *mutatis mutandis* to claim 13. Accordingly, Applicants respectfully request reconsideration and withdrawal of the rejection of claim 13.

Claims 14 and 15 ultimately depend from claim 13. For at least the reasons set forth above in connection with the patentability of claim 13, Applicants respectfully request reconsideration and withdrawal of the rejection of claims 14 and 15.

Conclusion

Applicants submit that claims 1-16 distinguish patentably and non-obviously over the prior art of record and are in condition for allowance. An early indication of allowability is earnestly solicited.

If any extension of time in necessary in connection with this Response, Applicants hereby petition for such extension. If any fees are due in connection with this Response, the authorization to charge deposit account 14-1270 for the fees associated therewith is hereby provided.

Respectfully submitted,

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